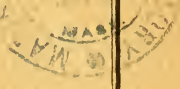
Gulf Biologic Station

CAMERON, LOUISIANA.

BULLETIN NO. 4.



The Conditions For Oyster Culture in the Waters of the Parishes of Vermilion and Iberia, Louisiana.

BY

L. R. CARY, M. S.

Issued By the Louisiana State Board of Agriculture and Immigration.

CHAS. SCHULER, Commissioner.

BATON ROUGE:
THE TIMES, OFFICIAL JOURNAL OF LOUISIANA.
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GULF BIOLOGIC STATION

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OFFICE OF THE DIRECTOR.

BATON ROUGE, LA., January 24, 1906.

His Excellency, Gov. N. C. Blanchard, President of the Board of Control of Gulf Biologic Station, Baton Rouge, La.:

SIR—I beg to submit the report of Mr. L. R. Cary, Zoologist of the Gulf Biologic Station, upon the conditions for oyster culture in the waters of Vermilion and Iberia Parishes, Louisiana. This report is the result of over two months' investigations in the waters of Vermilion Bay and vicinity. Mr. Cary's report contains information which should be of immense value to oyster culturists and to every one interested in the protection and development of the oyster fields of Louisiana.

Very respectfully submitted,

B. H. GUILBEAU, *Director.*

OFFICE OF THE DIRECTOR.

BATON ROUGE, LA., January 24, 1906.

Hon. Chas. Schuler, Commissioner of Agriculture and Immigration, Baton Rouge, La.:

SIR—I herewith present to you the report of Mr. L. R. Cary, Zoologist Gulf Biologic Station, upon the conditions for oyster culture in the waters of Vermilion and Iberia Parishes, Louisiana, and ask that you publish it as Bulletin No. 4 of the Gulf Biologic Station.

Very respectfully,

B. H. GUILBEAU, *Director.*

CONTENTS

The Conditions for Oyster Culture in the Waters of Vermilion and Iberia Parishes, Louisiana.

By L. R. Cary.

Introduction.

The following report is based upon a study of the physical and biological conditions of the natural and planted oyster beds in Vermilion and Iberia Parishes.

In July and August the writer, in company with Prof. B. H. Guilbeau, director of the Gulf Biological Station, spent a period of eight days in this region making a rapid preliminary survey of the field. At the time it was expected that the work would be taken up at once, but owing to the interference of quarantine restrictions, all further investigations were postponed until a later date. On October 17 the work was resumed and carried forward as rapidly as the weather would permit, being completed on December 23.

The objects of these investigations were, first, to ascertain the location, the extent, and condition of the natural oyster reefs in this locality; second, to study comparatively the biological condition of present producing areas; third, to study the physical and biological character of the bottom and water in areas not now producing oysters, for comparison with the condition prevailing in good oyster producing areas in this and other sections.

In studying the physical and biological conditions of any areas, the following factors were taken into account: First, the character of the bottom as affecting the condition of oysters; second, the salinity of the water; third, the organisms that make up the food of oysters, their abundance and distribution; fourth, the destructive agents, including under this head freshets, animals that directly destroy the oysters, and those animals and plants which, by their presence, interfere with the normal functions of the oyster.

It is a pleasure to acknowledge my indebtedness to Prof.

B. H. Guilbeau for his enthusiastic co-operation at all stages of the work. I am also indebted to Col. James Breaux, president of the Oyster Commission of Louisiana, for placing at my disposal the data concerning the leased areas in the territory under investigation.

Methods.

During the pursuit of these investigations, methods already used by previous investigators have been used wherever possible, in order that the results might be more readily compared with those already recorded for other locatlties.

The salinity of the water was determined in the usual manner, Hildegard's Oceanic Salinometer being used. For absolute accuracy in this determination a correction to a temperature of 15 degrees centegrade (60 degrees Fahr.) must be made; but as the temperature correction in any instance would be so slight as to be of no practical importance, it was neglected in all cases. The sample of water for the salinity determination was taken one foot from the bottom by means of a bottle lashed to a pole. Water from the several stations was examined at various stages of tide, and under various weather conditions. Averages of all these readings were made, and are given in the food tables.

The apparatus for determining the direction and velocity of the current was modeled after that used by Dr. Caswell Grave in his study of the North Carolina oyster fields, and fully described in his report. (a)

For determining the food value of the water over any bottom, a sample was collected one foot from the bottom by means of a litre bottle lashed one foot from the end of a pole. When the pole was thrust to the bottom the cork was drawn by means of a string attached to it, and when the bottle had filled it was brought up, recorked and labeled. A number of oysters were tonged from the same locality and three of average size collected. The contents of the stomachs of these were removed, as soon as possible after they were taken from the water, and the number of diatoms estimated by means of the Rafter Cell. The total number food forms found when divided by three gives

(a) Caswell Grave—Investigation for the promotion of the oyster industry of North Carolina. Report U. S. Fish Commissioner 1903, pp. 247-341.

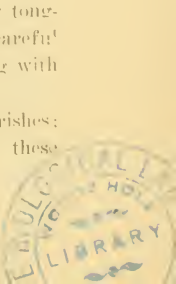
the amount for each oyster. When the food value of water over a barren area was to be determined, a number of oysters were transferred to that place, and after having been left there four days, were taken up and their stomach contents examined in the usual manner. The sample of water was allowed to stand until all of the sediment and organisms, except actively swimming forms, had settled and formed a definite layer on the bottom of the bottle. The water was now siphoned off to as low a level as possible without disturbing the settlings. The remaining water and settlings were, after being vigorously shaken, transferred to a small graduated bottle and allowed to settle.

After a second siphoning away of the water, the contents of the bottle, which now had a volume of either ten or fifteen cubic centimeters, were shaken up and one cubic centimeter was taken off for a determination of its food contents. The diatom count was repeated twice and an average of the three determinations taken, the number of diatoms of the same species as those found in the stomach of oysters from the same locality being given as the food value of the water. In all determinations of the food value of water, and the contents of the oysters' stomachs, the number of the smaller forms of diatoms have been left out of account, since it has been determined that by counting the larger forms only can we get as accurate a measure of the amount of available food material as we could if all forms were included in the count.

The character of the bottom was determined by the use of a sounding pole. Intersecting lines of soundings were made at short distances apart so that each area was thoroughly gone over. In determining the extent of the natural reefs the method of running intersecting lines of time soundings was used, and points on the borders of the reef were located by compass bearings from chartered points.

The condition of the natural reefs was determined by tonging oysters from several parts of each reef and making a careful count of the oysters, spat, dead shells, and animals living with the oysters.

The Natural Oyster Beds of Vermilion and Iberia Parishes: General Description of the Region—The area in which these



investigations were made includes Vermilion Bay and its tributaries, lying partly in Vermilion and partly in Iberia Parish, and also a portion of the Gulf of Mexico, extending from a point about six miles west of Southwest Pass, to the east end of Marsh Island. Vermilion Bay is a body of water about twenty-five miles long and fifteen miles wide. It is separated from the gulf by a narrow strip of low, marshy land. Two communications between the bay and gulf exist; one of these, known as Southwest Pass, is a narrow inlet with a very deep channel; the other outlet is through East and West Cote Blanche bays, on the north side of Marsh Island.

Many small bayous empty into the bay on its northern and western sides. Some of these bayous are outlets of extensive canal systems that drain large areas of the low, swampy country lying to the north of the region under consideration.

The depth of the water in the bay varies from six to twelve feet, being greater in the southern part than in the north. The bottom in the low, southern part of the bay, is soft, except in places where natural or artificial beds of oysters exist. Over the upper part of the bay the bottom is generally firm, only isolated patches of soft bottom being found. In the southwestern corner of the bay there is another large area of firm bottom.

The tidal current is strong in all parts of the bay. The force and direction of the current depending more on the wind than upon the diurnal rise and fall of the water.

At the present time the only productive areas of any importance in Vermilion Bay are included in what is essentially one large reef that extends in a northeasterly direction from a point just inside of the entrance of Southwest Pass to a point about two miles southwest of Cypremort Point. The depth of water over this reef is from three to six feet, except at the upper end, where there is an area about two acres in extent that is exposed at very low tide. The width of this reef varies from two hundred to six hundred yards. At a number of points the reef is traversed by a narrow channel. A prolongation of this reef extends at a right angle to the main reef nearer its north end. This last reef is one-half mile long by one-fourth mile wide.

The conditions of this reef are shown in the following table, which gives the amount of cullings found while securing one peck of salable oysters.

Location.	Dead Shells.	Smalls Oysters and Spat.	Mussels.
South end reef....	54	317	0
Middle part reef..	68	284	13
North end reef....	120	563	79

The most noticeable feature of these counts is the great number of young oysters and spat found. Many of the spat were less than five millimeters in diameter; some, indeed, being only three-fourths of a millimeter, showing that they had been attached not more than two weeks at the longest. The small portion of adult oysters found is due to the fact that during the past spring and summer hundreds of barrels of oysters were taken from this reef to be bedded in other parts of the bay and its tributaries; besides, the boat using dredges had been at work daily on this reef for some three weeks before the counts above recorded were made.

In other portions of the bay, and especially in some of its tributaries there were formerly some important beds. The largest of these were the ones in Hell Hole and in the bayous about Lake Fearman.

The beds at Hell Hole were in shallow water, and at times when there was a heavy north wind the entire bed was dry. At such times the oystermen were accustomed to go about and pick up the oysters, leaving them in piles to be taken up when the beds were again covered with water.

The beds in the bayous about Lake Fearman were in from eight to fifteen feet of water.

As both of these areas produced especially fine oysters they were kept fished down very closely. The prolonged freshet of the past spring completed their destruction, so that at the time of my visit not a single live oyster could be found on any of these reefs.

In the northeastern arm of Vermilion Bay, called Weeks Bay, there are isolated clusters of oysters scattered over the

most of the bottom. Most of the larger oysters in these clusters are dead, but most of those less than one and one-half inches in length are alive and growing rapidly.

Natural Reefs in Southwest Pass.

Southwest Pass, the westerly connection between Vermilion Bay and gulf, is about four miles in length. On the eastern side there is a deep, narrow channel, while on the west side there are extensive mud flats that are exposed at low tides. A narrow, tortuous channel navigable for small boats, passes around on the west side of these mud flats. The greater part of these flats are covered with clusters of raccoon oysters. These are arranged in long, narrow reefs that have their ends perpendicular to the small shallow channels, which cut up the flats.

The oysters that make up these reefs are arranged in clusters of ten to twenty. They are all small and misshapen on account of being so densely crowded. A dense growth of a blue green Alga about one-half of an inch long covers the entire exposed surface of oysters and dead shells. Mussels occur abundantly in the spaces between the oysters of each cluster. The condition of the oyster on these reefs is always poor, as the amount of food material available for each individual is small, and the time in which the food may be secured is limited to one or two hours before and after high tide. These oysters are, while the reefs are dry, subjected to intense heat in the summer, and sometimes to freezing temperature in the winter.

On the western side of the small channel mentioned above, there are many small exposed reefs of "coony" oysters, and also a few reefs that are covered at all stages of the tide. Oysters of good quality are found over limited areas on some of these deep reefs, but in small quantity only.

On the east side of the main channel of the pass there are a number of scattered reefs that cover the greater part of the area between the channel and the shore. The reefs near the channel are covered by five to fifteen feet of water, while many of those farther in shore are exposed at low tide. These reefs are made up of highly elongated thin shelled oysters arranged in clusters. The clusters spring from an old empty shell buried deep in the soft mud. As many as twenty-five or thirty oysters,

ranging in size from six to seven inches long to small spat, are found in a single cluster.

On some parts of these reefs many of the oysters are covered with a dense growth of hydroids several inches in length The presence of the hydroid seriously interfere; with the feeding of these oysters. as is shown by comparing the stomach contents of oysters taken from these areas with that of oysters taken near by where no hydroids are found.

During the present season a number of tongmen were working on these reefs during the greater part of the time, and during periods of stormy weather many of the boats that usually work on reefs outside of the pass, were engaged in fishing here, where they would not be exposed to rough water.

At the extreme western point of Marsh Island is a small reef that is exposed at low tide. This reef is made up of dead shells, among which are a few scattering oysters of good quality. Extending towards the channel from this dry reef is a reef covered with two to six feet of water, composed of clusters of elongated, densely crowded oysters of poor quality.

Natural Reefs in the Open Gulf.

The natural reefs located in the open gulf on each side of Southwest Pass are, both in regard to the area covered and the quality of oysters produced, by far the most important in this region. The salinity of the water in this portion of the gulf is lowered by the flow of fresher water from Vermilion Bay through the pass, and also to some extent by the water coming from the Atchafalaya River around the east end of Marsh Island, so that at all times it is well within the limit of salinity suitable for the growth of oysters. During the time while these investigations wee being made extremes of salinity recorded were ~~one point~~ 1.0093 and ~~one point~~ 1.0176 for water taken one foot from the bottom at a point one mile off shore and three miles to the west of the mouth of the pass.

On each side of the entrance to the pass there is a large reef extending out into the gulf. The reef on the west side is the larger of the two. It extends out along the edge of the channel for about three-fourths of a mile. Its width varies from two hundred to six hundred yards. At a point near its inner

end there is a small area about on-half acre in extent that is exposed at low tide. The water over the remainder of the reef varies from two to sixteen feet in depth. The oysters on this reef are mostly elongated, thin shells, and arranged in dense clusters.

At a few points on this reef there are a limited number of oysters growing singly, or in clusters of only two or three. These are found on the borders of the reef, where they have been broken off from the parent cluster and fallen on a clear bottom of sufficient firmness to afford them support. An abundant growth of hydroids two or three inches long is found on most of the oysters taken from this reef.

The reef on the east side of the entrance to the pass extends from the dry reef at the end of Marsh Island along the edge of the channel for about half a mile. It is interrupted at a point about half its length from shore by a channel fifty yards in width. Throughout its length it is much narrower than the reef on the west side, and the water covering it is generally deeper.

The oysters over the greater part of this reef are of the elongated cluster type; although there are a good many more shaped ones than on the reef last mentioned. On the eastern (inshore) side of the reef, where the surrounding bottom is composed of hard mud, many oysters of good shape and condition are to be found. Near the ruins of an old lighthouse that formerly stood on the west end of Marsh Island some especially large, good shaped single oysters were taken by the tongmen. These oysters were growing on a bottom composed of a few inches of soft mud overlying a substratum of firm clay. All the other conditions, besides the fact that these oysters were not crowded, were the same as those to which the elongated oysters nearby were exposed, and yet their shape and condition were as different as though they had come from different reefs.

A number of boats were constantly working on these two last mentioned reefs. Most of the oysters taken from here were used for steam oysters by the cannery at Avery Island, although some of the men carrying oysters to Franklin and other markets obtained a part of their loads on these reefs.

About four miles west from the entrance of Southwest Pass there is a reef that extends from the shore, approximately for one mile. Although narrow at its inshore end, where at low tide it is dry, its width increases rapidly a little away from the shore, so that at a distance of three hundred yards from shore the reef is half a mile wide. This reef, known locally among the fishermen as the "Little Hills" reef, has in the past produced an abundance of oysters of large size and exceptionally good quality. At the present time the supply of oysters on this reef is very limited, due to excessive fishing, so that during the present season few of the tongers have found it profitable to work here. A number of dredge boats have worked over the outer portion of the reef, securing a good catch of fine oysters. Counts of the cullings separated while tonging one peck of good oysters from different parts of the reef are given below:

Oysters.	Young Oysters and Spat.	Shells.
1 peck	89	113
1 peck	38	107
1 peck	216	183

Many of the spat and young oysters less than two inches in length are found attached to the large oysters, which usually occur singly, so that it is an extremely difficult matter to separate the cullings without destroying them.

In the open gulf, off Marsh Island, extending from a point about two miles from the west end to the eastern point, there is an almost continuous mass of reefs. Some of these are high and composed almost entirely of dead shells, while others constitute the most valuable producing areas of the regions. The beds where the good oysters are found are, in most cases, connected with some of the dry reefs, and around the borders of all of the dry reefs a greater or less number of oysters of good quality are to be found. The most important reefs will be mentioned in more detail. A large reef covered with from two to five feet of water is located at the western border of the area under consideration. This reef extends about a mile from the shore, and is from one-half to three-fourths of a mile in width. At its inshore end it is narrow and exposed at low tide. The oysters found here are of good size and quality. While found in

abundance in isolated patches only, the number present over all of the reefs is sufficient to make profitable fishing for the tongers. The number of spat and young oysters below marketable size is large, almost every shell brought up having several attached to it.

Outside and to the eastward of the one just described is a large reef that extends outward for two and a half miles. This reef is made up of oysters of good quality, but at present the supply is limited, this reef, like most of the others, showing the result of over fishing. Three or four dredging schooners have fished on this reef for the greater part of the present season, and between these and the tongers the supply of good oysters is limited to isolated patches that have escaped notice.

Beginning at the outer edge of a large dry reef two miles out from Chenier LaCroix, in a southeasterly direction, there is a large reef known as Diamond reef. This reef covers an area of two square miles and produces oysters of fine quality. An account of the history of this reef since its discovery is instructive as showing the rapidity with which an especially productive area may be reduced to a state of commercial barrenness by excessive fishing. At the time when this reef was discovered four years ago two men could load a small lugger in a single day, as the oysters were large and most of them occurred singly, so that the labor of culling was reduced to a minimum. As soon as the existence of this reef became generally known, most of the boats fishing in the region flocked to the place and continued to fish there during the remainder of the season, with the result that at the beginning of the next season more than three times the amount of labor had to be expended to secure the same amount of oysters as in the previous season. The same extensive fishing with the correspondingly curtailment of the catch has gone on until at the present season there were only a few scattered areas of limited extent where it was profitable for the tongers to fish.

The men on the dredging schooners said that it was unprofitable to work on this reef because of the great amount of cullings that must be handled while securing a small number of oysters, although these would be of better quality than most of the ones secured elsewhere.

Two extensive beds, made up almost entirely of young oysters three to four inches long, are situated two and one-half miles off shore, about five miles east of Chenier LaCroix. Taken together, these cover an area of about four square miles. The depth of the water of these reefs varies from two to three and one-half feet. The clusters on these reefs consist of from four to six young oysters attached to an older shell. All of the oysters more than two years old were dead from some cause or other. Because of the shallowness of the water over these reefs they have not been worked to any extent, since all of the schooners working in this region are of too deep draft to pass over the reef except at full tide, and the size of the oysters is not such as to attract the tongmen. These oysters are growing very rapidly, and unless the cluster is broken up soon, they will become elongated and poor like those on all of the densely crowded reefs.

Farther to the eastward, along the shore of Marsh Island and between the high reefs of coon oysters, there are reefs of limited extent, where especially fine oysters are found. These reefs are kept cleaned up by the men fishing for the raw houses at Morgan City, and at the time of a visit to these reefs in December the men working in that vicinity said that there were only a very few oysters to be secured in any one place in the region.

Oyster Planting in Vermilion and Iberia Parishes.

Until a very recent date no attempt at planting oysters on a commercial scale was made in this region. The fishermen have been accustomed to bed their catch from day to day, awaiting the completion of their load. These temporary bedding grounds were usually on or near some reef, as that afforded the hardest, cleanest bottom to be found. The oysters were deposited in a layer of a foot or more in thickness to facilitate taking them up when they were to be marketed, the bedding grounds being marked off by stakes. In some instances oysters taken from the very important reefs in Hell Hole and Lake Fearman that were especially of good size and condition, but on account of the low salinity of the water in which they grew, of poor flavor, were put down for a day or two in the more salt water of the pass

or neighboring gulf before being carried to market. By this means their flavor was much improved and their value correspondingly increased.

A few years ago a small plant some acres in extent was made at the north side of Weeks Bay by the superintendent of the salt mine on Weeks Island. At the time this plant was visited in August, 1905, all of the oysters, large and small, were dead.

At the present time there are in Vermilion and Iberia Parishes fourteen leased areas, aggregating 1,622.1 acres. These leased areas are all in Vermilion Bay and its tributaries, with the exception of four small holdings in Mound Lake and bayou, on the outer side of Marsh Island.

The bottoms selected for planting purposes have been, with one or two exceptions, those where in the past oysters of good quality were found, but whereas the result of over fishing and freshets, the reefs have become practically extinct.

The method of planting used has been that of bedding seed oysters taken from the natural reefs in the bay of pass. The seed has been in most cases coony oysters taken from the densely crowded reefs. In some cases, at least, the seed oysters were put down just as they were taken from the natural reefs, without any attempt to break up the clusters and liberate the oysters composing them from the oppressive condition to which they had been subjected.

The beds were made with no preliminary hardening of the bottom, and over some parts of the plants the oysters were found to have settled into the mud until they were completely covered.

In no case, so far as could be learned by inquiry, has any attempt been made to establish an artificial reef by exposing clutch to afford a place of attachment for the free swimming fry when they are ready to settle down.

That fry are abundant in these waters during the breeding season is shown by the presence of young oysters on almost every foreign substance that would afford them support.

Owing to the unusually adverse conditions that prevailed during the past spring and early summer, when the water in the upper part of Vermilion Bay and its tributaries was absolutely

fresh for a long time, all the bedded oysters, as well as the few natural ones remaining in Lake Fearman and its bayous, Shark Bayou, Bayous Chin, Chêl and Mochan, succumbed, so that at the time these investigations were made not a single living oyster was found among the hundreds of dead shells taken up from these beds.

As the future development of the oyster industry must depend chiefly on the product of artificial beds, since the natural ones are being so rapidly depleted, particular attention was given to the consideration of area available for planting purposes. The character of the bottom, salinity of the water, the amount and distribution of food organisms, was carefully studied in places not now containing natural reefs nor artificial beds. Where oysters from the natural reefs were put down in barren areas to determine the available food supply, the effect of the changed conditions on their condition and flavor was carefully recorded.

The area of bottom available for cultural purposes in Vermilion Bay is limited chiefly by the probability of freshets. Damaging freshets in this region come from two sources: First, from the bayous emptying into the upper part of the bay, and, secondly, from the Atchafalaya River, which in times of freshets sends large volumes of its water westward through the bays on the north side of Marsh Island to empty into the gulf through Southwest Pass. The writer is informed that during the past spring the water on the surface at the pass was absolutely fresh for several weeks from the flow of Atchafalaya water. It is probable, however, that a little way below the surface the salinity of the water was very near to normal, since very few dead oysters were found on the natural reefs at this point. In the lower part of the bay, where the salinity of the water is more stable, the bottom is so generally soft that the few hard spots may be left out of account for all practical purposes. While too soft to support seed oysters in the quantities best suited to their growth, this bottom at its worse is susceptible to hardening by the application of shells or sand. When prepared in the manner above described these hardened areas would undoubtedly produce an abundance of good oysters, since the food supply is constant and abundant and the salinity of the water stable.

The many bayous and lakes in the north side of Marsh Island are exposed to the periodic floodings with fresh water from the Atchafalaya, and as a result of the freshet of the past spring all of the oysters in them were killed.

In the southwestern arm of the bay the effect of freshets is less noticeable than in most other parts. Large areas of hard bottom suitable for the reception of shell or seed oysters are found here, and as the food and salinity conditions are favorable it affords one of the best locations for planting purposes.

That the conditions which prevailed in these waters during the past spring and early summer were unusually severe, is shown by the fact that up to the beginning of this protracted period of fresh water, adult oysters several years of age were to be found in most parts of the bay~~s~~, and in many ~~places in~~ the upper part of the bay. The presence of large oysters in these places would show that for some years previous to 1905 the freshets had not been severe enough to destroy the oysters in places where the full effect of the lowered salinity would be felt.

In Southwest Pass the area of bottom available for planting oysters is very small and everywhere composed of soft mud, so that artificial hardening would have to be resorted to in order to establish a bed.

In the open gulf, on both sides of Southwest Pass, there are large areas of bottom that offer exceptionally good conditions for planting.

Beginning at the border of the reef at the west side of the entrance to the pass there is an area of firm bottom, consisting of a substratum of clay, covered with two or three inches of soft mud, that extends for six or seven miles along the shore. The condition of the bottom is practically the same for a period of three miles off shore, while the depth of water is nowhere over twelve feet. The salinity and food conditions over this bottom were found to be essentially the same as those at Little Hills reef, which lies within the limits of the area under discussion, and which, for many years, has produced some of the best oysters found in these waters. The firmness of this bottom makes it directly available for planting without any preliminary hardening. The presence of natural reefs within, or on

the borders of this area, as well as the fact that it is swept by currents coming directly across these reefs, would insure a set of spat on shells exposed here.

On the east side of the pass off Marsh Island there is a large tract of bottom where the conditions are much the same as over the area just mentioned. This tract extends from the reef at the entrance to the pass to the western border of the great mass of reefs off Marsh Island. The bottom is uniformly firm for a distance of two miles from the shore. Beyond this point there is from five to fifteen inches of soft mud on top of the firm clay substratum. The salinity of the water and the amount of food contained in it over the whole of this area is favorable for the growth of oysters, and wherever any hard body is found on this bottom it has oysters growing on it.

Between the reefs farther to the west there are areas of soft bottom, which could, by some hardening agent, be brought to a state where they would afford support for artificial beds. The biological conditions on these areas are the same as those found on the natural reefs nearby, so that if the bottom were made firm enough to give support to oysters, we have every reason to expect good results from any plant that might be made here.

For a distance of from five to eight miles outside of Marsh Island, or one to four miles beyond the present reefs, there is a vast tract covered by not more than twelve feet of water, which, by artificial hardening of the bottom, would become available for oyster culture if the growth of the industry creates a demand for more planting ground than is found near shore.

Destructive Agents.

The enemies to the attack of which the oysters of this region are subjected are extremely few. No star fish are found; conks and drills, although present in small numbers, do no appreciable damage.

The drum fish, which does so much damage to bedded stock in some parts of the State, is comparatively harmless here, although one or two instances where bedded oysters have been destroyed by some enemy, probably the drum, are reported.

A boring sponge, probably *Cliona sulphurea*, is found quite

abundantly on some of the natural reefs. Most of the specimens found were small, and as they make only superficial burrows in the shells of the oyster, they are of no particular importance. In a later stage of its development this sponge forms large orange colored masses, that may entirely cover the oysters and interfere with their feeding, but, as before stated, none of the adult forms were found.

A boring clam, Martesia cuneiformis, is abundant in this region. This clam when very small bores into the shell of the oyster, and as the size of the clam increases, its burrow becomes correspondingly enlarged. These burrows are found in the superficial layers of the shell only and do no damage of importance.

The presence of algae and hydroids on the shells of oysters from some of the natural reefs acts as a detrimental agent by collecting sediment and decreasing the amount of food material that can be obtained by the oyster.

Among the oysters on some of the reefs mussels are present in sufficient numbers to seriously interfere with the oysters. Since the food of these forms is composed of the same kind of plants, the amount available for each oyster is lowered by the presence of the mussels.

By far the most formidable destructive agent to be encountered by one engaged in oyster culture in this region is the annual spring freshet, which lowers the salinity of the water in the bay and its tributaries during the feeding season of the oyster. While no authentic record of the freshets in years past is available, the best evidence obtainable shows that severe freshets like that of the past year have been of infrequent occurrence. However, the increasing number of drainage canals emptying into the head waters of Vermilion Bay make it probable that more damage from fresh water will occur in the future than has been the case in past seasons. These canals offer a means of escape for the water in the swamps which formerly could reach the bay only after a slow passage through the small branches of the bayous passing through the swampy area. The large volumes of fresh water that can reach the bay through

these canals after every heavy rain will make the salinity of the water in the upper part of the bay so unstable that oysters growing in this region will be in constant danger of being killed.

CONCLUSIONS.

The oyster reefs in Vermilion Bay and Southwest Pass are susceptible of being greatly improved by breaking up the clusters of oysters so that each individual oyster would have room to grow to its normal shape. This result will naturally follow from the working of the reefs, as only the larger oysters are removed, the smaller ones being returned to the bay. In any region where oysters grow on a soft bottom they are elongated and of poor quality until the reefs are broken up to some extent by the removal of oysters. The reefs in the gulf where good oysters are produced are in a depleted condition as a result of over fishing. A marked exception to this rule is seen in the two reefs of young oysters a couple of miles out in the gulf. Oysters are very abundant all over these reefs, and unless they are broken apart, densely crowded reefs of elongated oysters will result.

The prospect of building up a profitable industry by planting oysters is very favorable; large areas of bottom, admirably suited for this purpose, exist in the lower part of Vermilion Bay and in the neighboring gulf. Practically unlimited amounts of small oysters suitable for use as seed, exist on the shallow reefs in the pass and gulf. These oysters when separated and deposited on good bottoms will increase rapidly in size and show marked improvement in shape and condition. The practice of exposing shell to serve as clutch on which the spat may settle is to be recommended as a method of planting rather than the method of bedding seed oysters. By the use of the latter method there is no drain on the natural reefs, already in many cases sadly depleted; but, on the other hand, the actual number of oysters in existence in the region is increased by saving the spat, many of which would otherwise perish for want of a place of attachment. In cases where adult oysters have been placed on a bed of shells to furnish spat, it has been found that at the

end of two or three years it was impossible to tell the parent oysters from the younger ones, so rapid had been the growth of the latter.

Records of the known rate of growth of oysters in other parts of Louisiana, where conditions are no more favorable than these investigations have shown them to be in the waters of Vermilion Bay and the gulf, would show that in two years from the time of the settling of the spat, oysters of remarkable size would have grown on the beds. An artificial bed made by planting shells, would, if worked in a reasonable manner, be self-perpetuating and yield a steady supply of good oysters year after year.

The use of small shells, such as the clam shells found so abundantly at many points along the coast, will lessen the labor of caring for a plant. Fewer spat will settle on the small shells and the damage by crowding will be correspondingly lessened.

Bottom in the upper part of Vermilion Bay or its tributaries might be used for fattening grounds, to bed for a short time oysters grown in the more salt waters of the gulf. The salinity of the water in these sheltered places is in winter considerably lower than that of the gulf water, so that oysters put down in these places would show a marked increase in the amount of "meats" taken from a given number of oysters. These locations just mentioned, where there is especial danger from spring freshets, could be utilized as bedding grounds from the time one period of freshet had passed until the approach of the following spring. Oysters of good size put down on these grounds in the early fall would be in excellent condition, and would probably show a marked increase in size before the last of the oyster season.

The recovery of the planted areas where the oysters were killed by fresh water during the past spring would be brought about more quickly and surely by depositing on them some fully grown oysters to furnish spat at the coming breeding season. Moreover, the oysters that have grown on any bed from the time of their attachment are more hardy than those that have undergone the shock of handling and being exposed to a new set of physical, and to some extent, new biological conditions.

In the short period of time covered by this study it was im-

possible to form any accurate estimate of the rate of growth of oysters in this locality; but the men engaged in the industry give three years as their estimate of the time required for oysters to reach a good marketable size.

According to the best information obtainable the breeding season begins in April, and from the writer's personal observations, many of the oysters were ~~forming accurately~~ spawning actively as late as October 18. The unfavorable conditions of the past spring and the early summer, when the water was too fresh for spawning to take place, may account in part for the abundance of spat found later in the season.

It is the intention to make, at a later date, some experimental plants in this region to demonstrate the utility as planting grounds of the areas recommended for that purpose in this report.

CAMERON, LA., January 22, 1906.

APPENDIX

The figures given in the following tables are the averages of all determinations made at each station during the period of the investigations. The number of diatoms given in the last two columns are the numbers found in the stomach of one oyster and in one litre of water taken one foot from the bottom.

FOOD AND SALINITY RECORD.

Reef in Vermilion Bay.

Date of Examination.	Salinity of Water.	Condition of Oysters.	Number of Diatoms, of Oysters.	Diatoms, of Water.
October, 1905....	1.010	Poor	13,796	14,872
November, 1905...	1.0113	Fair	13,334	18,998
December, 1905...	1.0128	Fair	15,334	18 656

Reef on East Side of Southwest Pass.*

October, 1905....	1.011	Poor	11,266	19,998
November, 1905...	1.0123	Poor	12,397	15,589
December, 1905...	1.0135	Poor	11,998	14,872

Reef on West Side of Entrance to Pass.

October, 1905....	1.011	Poor	14,892	16,184
November, 1905...	1.012	Poor	17,259	18,726
December, 1905...	1.0132	Fair	15,124	20,428

Little Hills Reef (in Gulf West of Pass.)

October, 1905....	1.0132	Good	16,446	18,876
November, 1905..	1.0140	Good	18,666	15,728
December, 1905..	1.0154	Very Good	17,792	20,220

First Reef off Marsh Island to East of Pass.

October, 1905....	1.0122	Good	16,666	19,243
November, 1905..	1.0137	Good	19,492	17,664
December, 1905..	1.0143	Good	18,286	20,244

*The oysters from this reef were covered with a dense growth of hydroids as was mentioned in the body of the report.

Date of Examination.	Salinity of Water.	Condition of Oysters.	Number of Oysters.	Diatoms of Water.
Reef Near Mouth of Mound Bayou.				
December, 1905..	1.015	Very "Fat"	17,167	19,252
Between Pass and Little Hills Reef (Barren Area.)				
October, 1905....	1.0133	Good	17,983	18,347
November, 1905..	1.0137	Good	16,467	20,684
December, 1905..	1.015	Good	19,826	17,982
Barren Area off Western End of Marsh Island.				
October, 1905....	1.011	Good	17,646	20,220
November, 1905..	1.0136	Good	19,287	17,998
December, 1905..	1.0152	Good	16,446	16,583
Barren Area Lower Part of Vermilion Bay.				
October, 1905....	1.011	Fair	14,179	16,373
November, 1905..	1.0115	Fair	15,114	18,998
December, 1905..	1.013.	Good	18,267	17,763
Barren Area Upper Part of Bay.				
October, 1905....	1.004	None Present	.....	16,884
November, 1905..	1.0073	Good	16,408	18,296
December, 1905..	1.011	Good	15,272	17,747

EXPLANATION OF CHART.

The accompanying chart shows the location of the oyster reefs and planted areas, the depth of water and character of the bottom in different parts of the territory studied. The location and extent of any particular reef is shown only approximately, as no means of making an accurate survey was available. However, the actual amount of bottom covered by oysters will be found to be very nearly that shown on chart. No attempt has been made to distinguish between dense, medium or scattered growths, except in the upper part of Vermilion Bay and in Weeks Bay, where the scattered clusters are represented by a uniform red stippling.


NOTE.
Oyster beds are shown in red thus
The salinity of water in red figures S 1.011
Velocity of current by red figures above an arrow 1½ = 1.75 miles an hr.
Soundings are given in feet in black figures. B.
The following symbols denote character of the bottom:-
m=mud ; sft=soft ; hrd-hard.
VERMILION BAY
MARSH ISLAND
N
S
WEEKS BAY
SWANS BAYOU
CYPREMORT POINT
South West Pass
Atchafalaya Cross
hrd m
sft. m
hard m
S 1.007
S 1.011
S 1.009
S 1.0137
S 1.0142
S 1.0136
S 1.0148